EGW 2014
3rd European Geothermal Workshop
Karlsruhe, 15-16 October 2014

Monitoring of geothermal reservoirs by hybrid gravimetry

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Keywords: time-lapse gravity, monitoring, density distribution

ABSTRACT

Time-lapse gravity is a monitoring tool to investigate underground mass redistributions and hence finds a potential application to follow a geothermal reservoir both in its natural state or undergoing man-made stimulations. Several experiments have introduced the concept of hybrid gravimetry which is the optimal way to combine different types of instruments and techniques of measurement. In particular, hybrid gravimetry uses a reference station where gravity is continuously recorded with a relative gravimeter and regularly checked with absolute gravity measurements, as well as repetitions of a micro-gravimetric network of several satellite stations in the vicinity of the reference one.

The first results of the hybrid gravimetry concept applied to the Soultz-sous-Forêts geothermal reservoir will be given. We first report on the stability of the reference point (GPK1) from a series of absolute gravity measurements done with EOST ballistic gravimeter (FG5 model of Micro-g Solutions).

We establish a repetition network of 11 relative stations linked in 5 separate loops around GPK1 station. The survey is routinely done with a Scintrex CG5 microgravimeter on a weekly basis during four months in July and August 2013 and again in July and August 2014. An additional loop has been set up to include also the ECOGI site near Rittershoffen where several injection tests are planned in the near future.

We will show the preliminary temporal gravity variations (double differences) derived from these repetitions, after removal of the instrumental drift and applying precise tidal corrections. It turns out that the 2014 micro-gravimetric measurements are much better than the 2013 ones mostly because of the use of a more stable instrument, reducing the average loop error by almost a factor 10. We will hence infer a threshold for detecting any gravity signal of geothermal origin in the frame of our local network.

We will also provide very preliminary results on the modeling of expected variations in surface gravity due to deep density changes that may occur in the Soultz and Rittershoffen geothermal reservoirs.